Commercialization of a New Starch-Based Polymer

WILLIAM M. DOANE

Northern Regional Research Center, Agricultural Research, Science and Education Administration, U.S. Department of Agriculture, Peoria, IL 61604

This paper provides an example of commercialization of a product invented during in-house federal research. Various events are described that played a role in transferring the technology to the private sector.

The product was a starch-based polymer with unique properties for absorbing large amounts of aqueous fluids. The research leading to the absorbent product is part of a program directed towards developing renewable agricultural commodities as partial or total replacements for petroleum-derived products. In this specific research project, we have been studying the chemical bonding of synthetic polymers to starch, a natural polymer produced in great abundance in many agricultural crops.

Our early research pointed out that the best way to covalently bond synthetic and natural polymers was via a method referred to as graft polymerization. In this technique, reactive sites are formed on the starch backbone and then the appropriate monomer (the individual building unit of the polymer) is brought into contact at the reactive sites and caused to polymerize. Acrylonitrile, a polymerizable monomer, readily graft polymerizes onto starch to yield a copolymer in which the synthetic polymer, polyacrylonitrile, is covalently bonded to starch. Treatment of the starch-polyacrylonitrile (S-PAN) with sodium hydroxide converts the S-PAN to a highly hydrophilic composition possessing excellent properties for a thickening agent.

Although the thickening properties of the hydroxide-treated S-PAN were predicted and, in fact, were the properties being sought, an unexpected property of the polymer, that of water absorbency, was not expected. We found that on drying the thickened dispersion, a solid product was obtained which, when added to water, would absorb hundreds of times its weight of water but would not redissolve. The initial observation of this property was made when a film that formed on evaporation of a thickened dispersion of hydrolyzed S-PAN was placed in a shallow tray containing water. The film rapidly imbibed the water and increased in surface area about thirtyfold. The swollen film

showed an increase in weight of about 300 times over the dry film. (Further studies of this polymer resulted in products that would absorb 2000 times their weight in water.)

Discussions among the group involved with the discovery of the absorbent and a search of the literature to help assess its uniquness resulted in a somewhat different approach to reporting the discovery than was usual in our Laboratory. Compiling a list of potential applications, where enhanced absorption of aqueous fluid would be desirable, caused us to report the discovery not only in the scientific literature but also in trade journals and the popular press.

Little did we realize at the time the impact our information officer, who was responsible for preparing news releases for the popular press and trade journals and magazines, was to have on the successful commercialization of the product. As the four scientists were describing the product to him and demonstrating how rapidly the product would absorb hundreds of times its weight of water, he quickly gave it the name Super Slurper. He explained, much to the chagrin of the four scientists, that a name other than hydrolyzed starch-polyacrylonitrile graft copolymer was needed if we were to communicate with the public. We now recognize how right he was and how significant a role the name he gave to the absorbent has played in promoting the product.

He prepared several news releases whose contents varied depending on the audience he intended to reach. Largely through his efforts, our Center received several hundred inquiries in the first few months for more information on the Super Slurper. (We estimate that over the 5-year period since the first announcement, we have received and responded to over 5000 inquiries.)

It had been decided before the first news release was sent out that we should prepare some printed material in addition to the scientific paper we had written. An information sheet was prepared that was of more use in responding to the general inquiries than was the scientific paper.

Our next decision, that of providing small samples of the absorbent, played, I believe, a very significant role in the road to commercialization. We realized that the small sample (a few grams) was insufficient for evaluation in an end-use application, but it did serve to further pique the interest of the recipient. Continuing requests for samples caused us to turn away from laboratory glassware and to a larger reactor in which a few pounds of the starch product could be prepared. It should be mentioned here that our mission is to conduct basic, long-range research of a high-risk nature that the private sector does not carry out. We do not perform the development research which the private sector, with its expertise, can do so much more efficiently. hus, in going to a larger reactor, engineering or development studies were not undertaken.

Preparation of the larger quantities did serve to demonstrate the feasibility of making the polymer in systems other than

laboratory glassware. It also provided us with enough information to enable us to come up with a preliminary cost-to-make estimate. This rough estimate permitted us to respond to the question on cost of the polymer that came up so often. The paper we wrote covering the larger scale preparation and the cost estimate turned out to be quite useful, especially to the small company.

We used the great interest shown in the polymer and some of the feedback from those receiving samples to attempt to encourage private industry to undertake development studies on Super Slurper. The discovery was patented and royalty free, non-exclusive licenses were available from the U.S. Department of Agriculture. The reluctance by private industry to undertake development of Super Slurper without a proprietary position was partially overcome, when it was recognized that innovations arising during design of a commercial process might well offer them the opportunity for patenting. Another incentive for the industry was that we would provide the names of those licensees who were producing the product in developmental quantities to all who contacted us about Super Slurper. In order to do this, we required a letter from the licensee stating that they would respond to all inquiries they received. As of this writing, the U.S. Department of Agriculture has issued 42 licenses, and 5 of the licensees have asked to be listed as suppliers of developmental quantities. We have been told by one of the suppliers that our listing of their name had resulted in over 1000 inquiries.

In late spring of 1978, the first company to obtain a license opened a plant and started commercial production of the absorbent polymer. Another of the licensees has been producing several thousand pounds per month for nearly a year. Some others have informed us they are now completing pilot-plant studies.

As increasing commercial quantities become available, the list of uses for Super Slurper grows rapidly. Currently we are aware of its use in such diverse areas as disposable soft goods to absorb body fluids, removing water from pulverized coal, seed and root coatings, thickening water in fighting forest fires, hydroseeding to establish plant growth on new construction sites, removing traces of water from organic solvents, and as an absorbent in hand powder for athletes. We have been informed by the private sector that their market estimates suggest a U.S. market of about 1 billion pounds per year for Super Slurper.

RECEIVED March 14, 1979.